MINING AND MILLING METHODS AT SAN XAVIER MINE THE EAGLE-PICHER MINING & SMELTING CO. PIMA COUNTY, ARIZ.

By Grover J. Duff and Charles A. Kumke

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Grover J. Duff[1] and Charles A. Kumke[2]

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INTRODUCTION AND SUMMARY

This paper describes mining and milling practices at the San Xavier mine of the Eagle-Picher Mining & Smelting Co. in Pima County, Ariz. It is one of a series being prepared by the Bureau of Mines on mining methods in various mining districts of the United States.

The mine and the mine surface buildings are situated in sec. 11, T. 17 S., R. 12 E., in the Sierrita Mountains in Pima County, 20 miles south by southwest from Tucson via the San Xavier Mission and Twin Buttes road (fig. 1). A well-maintained dirt road continues southward toward Twin Buttes for 4 miles and then branches off northeasterly for 5-1/2 miles to Sahuarita, where the concentrator of the Eagle-Picher Mining & Smelting Co. is situated on the west slope of the Santa Cruz River Valley. The mill is connected by a railroad branch to the main line of the Southern Pacific Railroad between Tucson and Nogales.

It is generally assumed that the San Xavier silver-lead deposits became known to the Jesuits and Spaniards in the early part of the eighteenth century. However, no extensive mining operations were conducted by the Jesuits in what is now Arizona before the middle of the eighteenth century. The completion of the Southern Pacific Railroad from Los Angeles to El Paso in 1881 marked the beginning of intense activity in mining throughout the southern part of the State.

The San Xavier mine produced 6,000,000 pounds of lead, considerable zinc (exact figures not available) and $200,000 in silver from 1897 to 1918.

The Eagle-Picher Mining & Smelting Co. re-opened the San Xavier mine in 1943 and built a 175-ton concentrator at Sahuarita. The capacity of the plant was increased in 1944 to 500 tons in order to take in custom ore.

The surface rocks at the San Xavier mine are, in great part, of sedimentary origin. Limestones of various ages comprise most of the exposed sedimentaries, some quartzites and shales also being present. The sedimentaries rest upon coarse-textured, intrusive, igneous rocks comprised mainly of granite and granodiorite.

The San Xavier deposit is composed of galena, sphalerite, chalcopyrite, and pyrite. Generally the individual ore bodies are small, discontinuous, and occur as irregularly spaced shoots or lenses. The present mine workings extend horizontally a distance of 2,700 feet and vertically 900 feet. Owing to ground weight, all mine openings are timbered on the levels and all stopes are square-setted and waste-filled.

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A considerable amount of underground core drilling is done in connection with development. The drill holes in the lower level also are useful in gradually lowering the water table. At the present time the mine is pumping a million gallons of water a day. With the aid of two suction fans and carefully placed ventilation doors on all main levels, comfortable working temperatures are maintained throughout the mine.

No regular cut samples are taken. A grab sample is taken from each car of ore at the shaft station. Blasting in a number of small stopes on every shift requires prompt analysis of the grab samples. The bosses readily learn to distinguish ore from waste by the character and appearance of the ore.

Virtually all mill employees are furnished housing facilities at the mill site. Key mine employees are furnished houses at the mine, and others live in Tucson. Large comfortable buses operated under State franchise provide transportation for all mine shifts.

Since 1943 the San Xavier mine has been an important producer of lead and zinc. In 1947, according to United States Bureau of Mines Mineral Yearbook, it ranked third in the production of these metals in Arizona.

ACKNOWLEDGMENTS

Acknowledgment is made to the Eagle-Picher Mining & Smelting Co. for permission to publish this report and to E. H. Crabtree, chief metallurgist, for his description of the milling practices. Special acknowledgment is made to G. W. Irvin, chief mining engineer, who was very helpful in conducting trips underground as well as explaining in detail the mining problems peculiar to this ore occurrence; and to L. F. Bayer, mine superintendent, and W. B. Loring, geologist, for furnishing valuable informaton on mine production and geology.

Acknowledgment also is made to the Arizona Bureau of Mines for information on the geology of the ore deposits.

HISTORY

It is generally assumed that the San Xavier silver-lead deposits became known to the Jesuits and Spaniards in the early part of the eighteenth century. In a United States Geological Survey publication, 3/ the following statement is made: "The year 1691 was marked by the first entry into Arizona of Father Eusebio Francisco Kino". The following is taken from Father Kino's Memoirs, written in 1705:4/ "In these new nations and new lands there are many good veins and mineral lands bearing gold and silver: and in the neighborhood and even in sight of these new missions and new conversions

3/ Bryan, Kirk, U. S. Geol. Surv., Water Supply Paper 499, 1925, p. 7.
4/ Bolton, H. E., Kino's Historical Memoir of the Pimeria Alta, Cleveland, 1919. p. 13.

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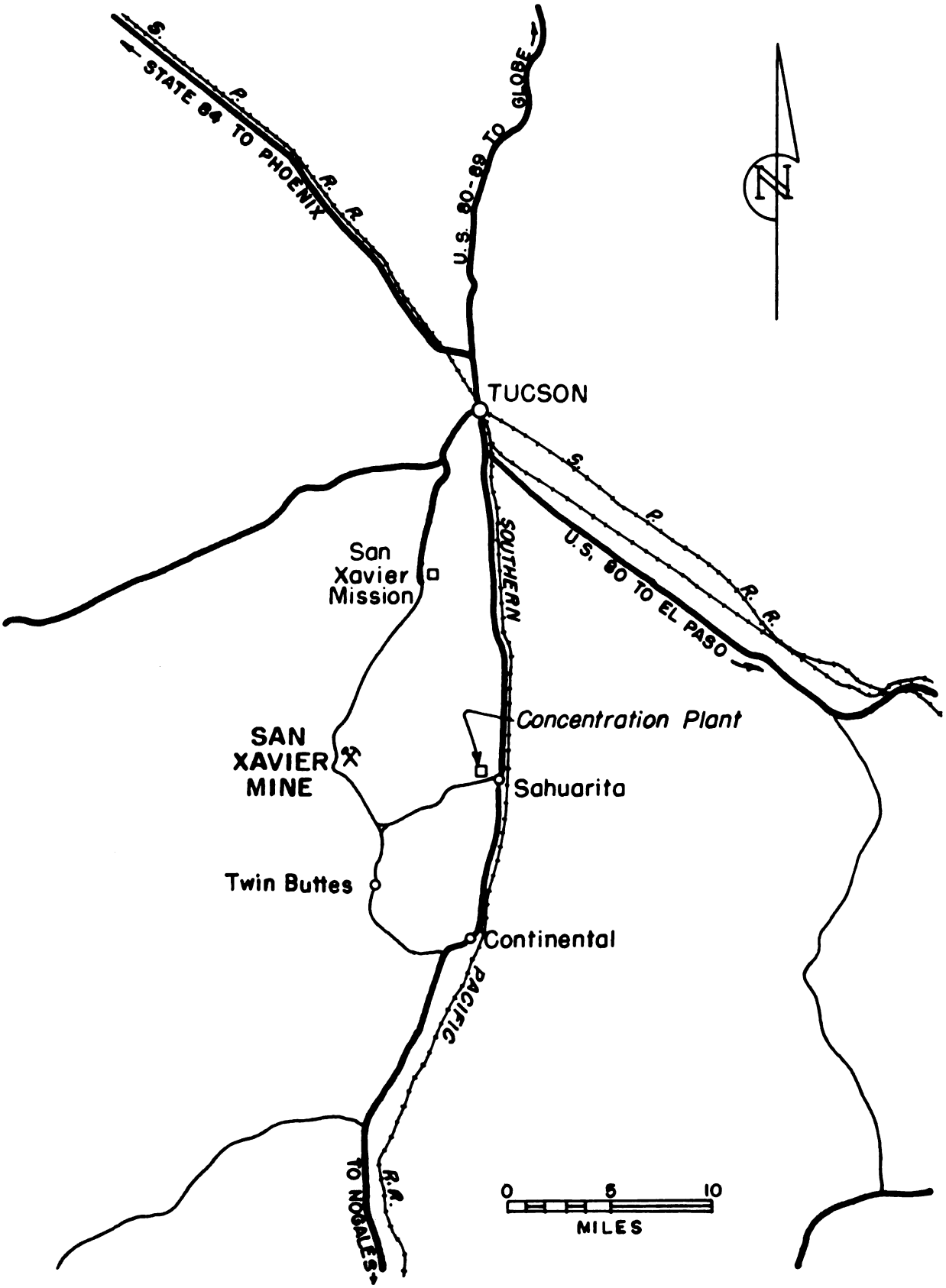

Figure 1. - Location map, San Xavier mine, Pima County, Ariz.

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some very good new mining camps of very rich silver ore are now being established". The above statement is followed by the author's opinion5/ that: "Probably some of the silver deposits of the Santa Rita Mountains were discovered about this time, but many writers on Arizona have undoubtedly erred in stating that extensive mining operations were conducted by the Jesuits in what is now Arizona before the middle of the eighteenth century."

Inaccessibility, lack of transportation, and the hostile Apache Indians held back development of southern Arizona. The completion of the Southern Pacific Railroad from Los Angeles to El Paso in 1881 marked the beginning of intense activity in mining throughout the southern part of the State.

Some development work was done in the San Xavier mine prior to 1875, but no authentic production records are available. Colonel O. P. Sykes bought the mine in 1880 and organized the San Xavier Mining & Smelting Co. This company erected a small blast furnace on the Santa Cruz River 9 miles south of Tucson, but its operation was not a success. From 1882 to 1893, intermittent ore shipments were made from the San Xavier mine as well as from a number of other mines in the Sierrita Mountains.

Owing to the demonetization of silver in 1893, all of these mines were closed. During 1897 L. H. Manning shipped some ore from the San Xavier mine, and then the mine again ceased operations.

No records are available covering the period from 1898 to 1912. However, A. W. Forbes told Grover Duff that he was mine superintendent at the San Xavier mine from 1899 to 1906 and that a Wisconsin or Minnesota company headed by a Mr. Brown operated the San Xavier mine during that time and performed extensive development work.

In 1912 the mine was bought by the Empire Zinc Co., and shipments of lead-zinc ores were continued until 1918. Another shutdown period that followed lasted for 25 years.

According to information published by the University of Arizona,6/ the San Xavier mine produced 6,000,000 pounds of lead, considerable zinc (exact figures not available), and $200,000 in silver from 1897 to 1918.

The Eagle-Picher Mining & Smelting Co. reopened the San Xavier mine in 1943 and built a 175-ton concentrator at Sahuarita. The capacity of the plant was increased in 1944 to 500 tons to take in custom ores. Since 1943 the San Xavier mine has been an important producer of lead and zinc. In 1947, according to United States Bureau of Mines Minerals Yearbook, it ranked third in the production of metals in Arizona. The following table shows the production of metal from the San Xavier mine for 1948 and 1949.

5/ Bryan, Kirk, previously mentioned in footnote 4.
6/ Elsing, M. J., and Heineman, R. E. S., Arizona Metal Production: Ariz. Bur. of Mines Bull. 140, 1936.

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Year	Silver, oz.	Lead, lb.	Zinc, lb.	Copper, lb.
1948.....	176,384.99	8,617,935	14,864,767	699,083
1949.....	274,516.17	9,637,071	17,260,303	1,009,398

GEOLOGY

The San Xavier mine is situated in a group of small hills rising steeply from the broad alluvial plain that slopes eastward from the Sierrita Mountains (fig. 2).

The surface rocks are, in great part, of sedimentary origin. Limestones of various ages comprise most of the exposed sedimentaries, some quartzite and shale also being present. Frequent faults and extensive alluvial covering prevent the exposure of these sedimentaries in their original entire thickness. In some places older sedimentaries have been thrust over younger beds. There are numerous steeply dipping faults in the district that greatly increase the difficulties in following the downward continuation of the ore deposits in the mine workings.

The sedimentaries rest upon coarse-textured, intrusive, igneous rocks, mainly granite and granodiorite. In places, porphyry dikes cut through the sedimentaries. These dikes are believed to be related to the granite intrusion.

The San Xavier deposit is composed of galena, sphalerite, chalcopyrite, and pyrite. These sulfides have replaced garnet and pyroxene (hedenbergite) as well as limestone. The major ore bodies occur in a zone bounded by a main fault and the base of the Cretaceous arkose, a sandstone derived from the disintegration of granite. These boundaries are roughly parallel, striking nearly east and west and dipping south at about 45°.

The silicates, garnet and hedenbergite, form pipelike to lenslike bodies in crystalline Permian limestone. The ore generally occurs in a crystalline Permian limestone against a hanging wall of arkose, quartzite, or gouge along a minor fault. In replacing the silicates, the ore bodies take on a pipe- or chimneylike form. Generally, the individual ore bodies are small and discontinuous. Oxidation extends 100 to 200 feet below the surface and in places a little deeper. Oxidized ores occur as cerussite and smithsonite, with some limonite and very sparsely distributed wulfenite.

The presnet mine workings extend horizontally a distance of 2,700 feet and vertically 900 feet.

MINE BUILDINGS AND MINING EQUIPMENT

The surface buildings (fig. 3) at the San Xavier mine include a mine office, warehouse (stock and equipment), two hoist houses, a compressor and powerhouse, machine shop, blacksmith shop, saw mill, change room, garage, and ten dwelling houses for key employees.

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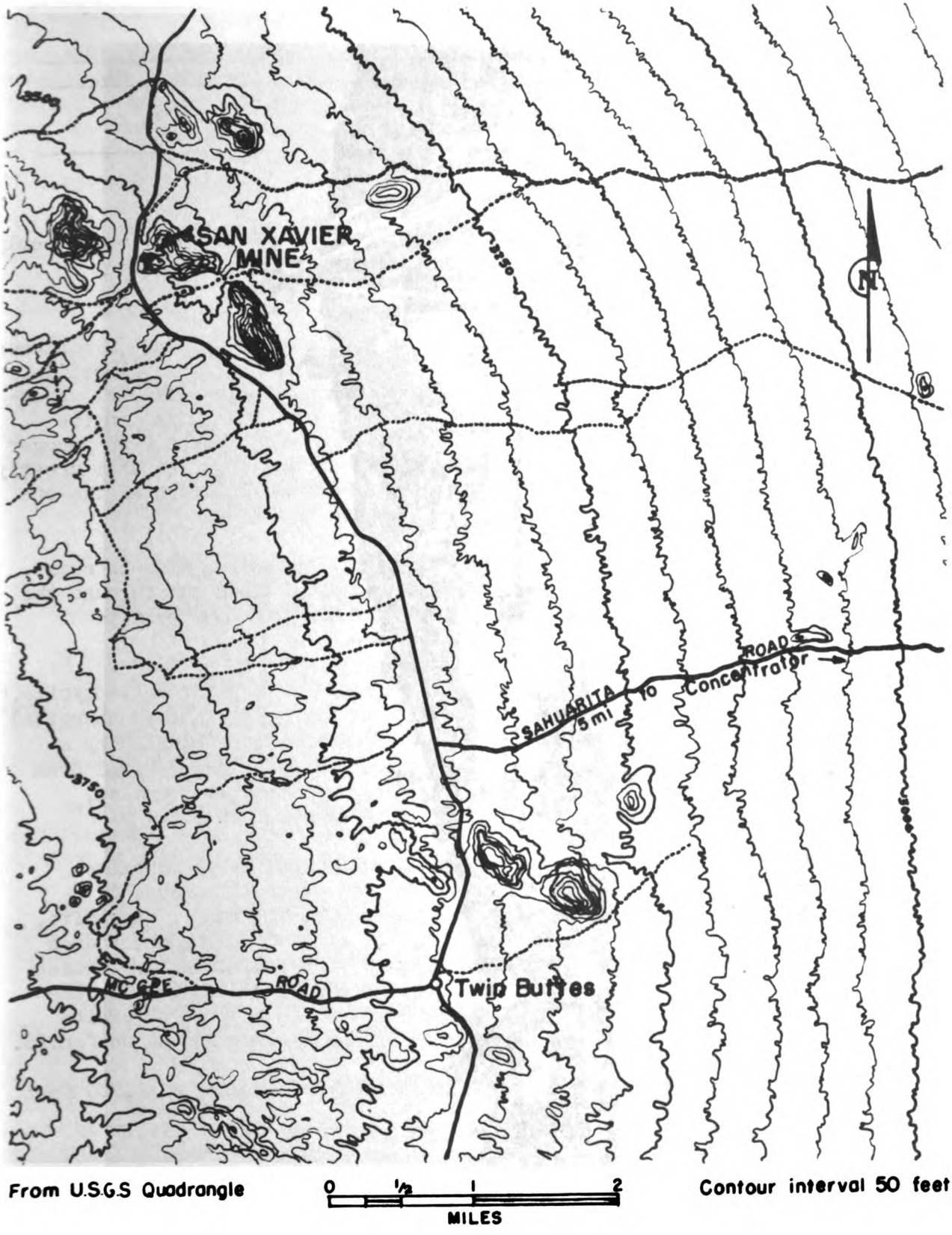

Figure 2. - Topographic map, San Xavier mine area, Pima County, Ariz.

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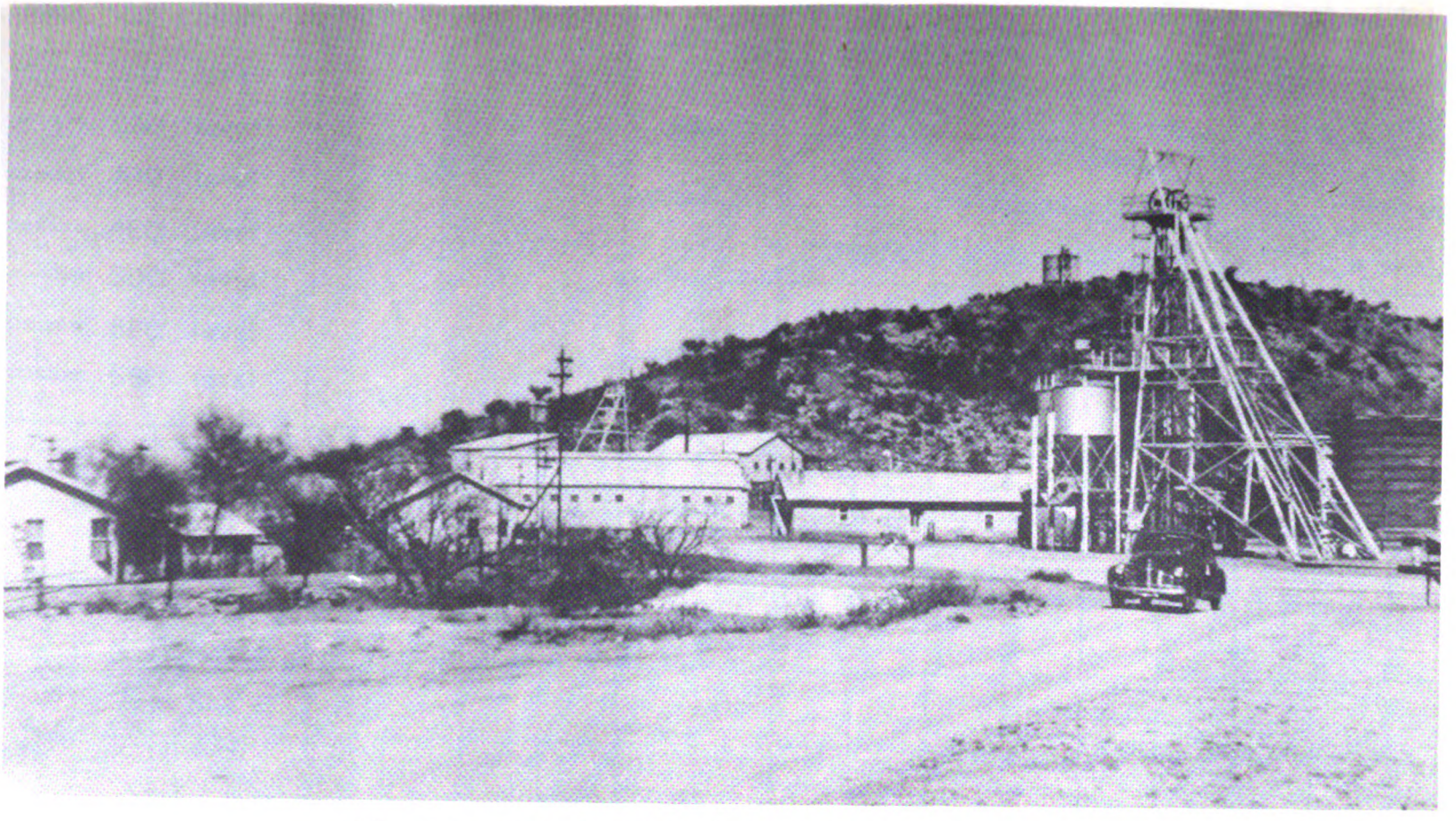

Figure 3. - Surface buildings, San Xavier mine, the Eagle-Picher Mining and Smelting Co.

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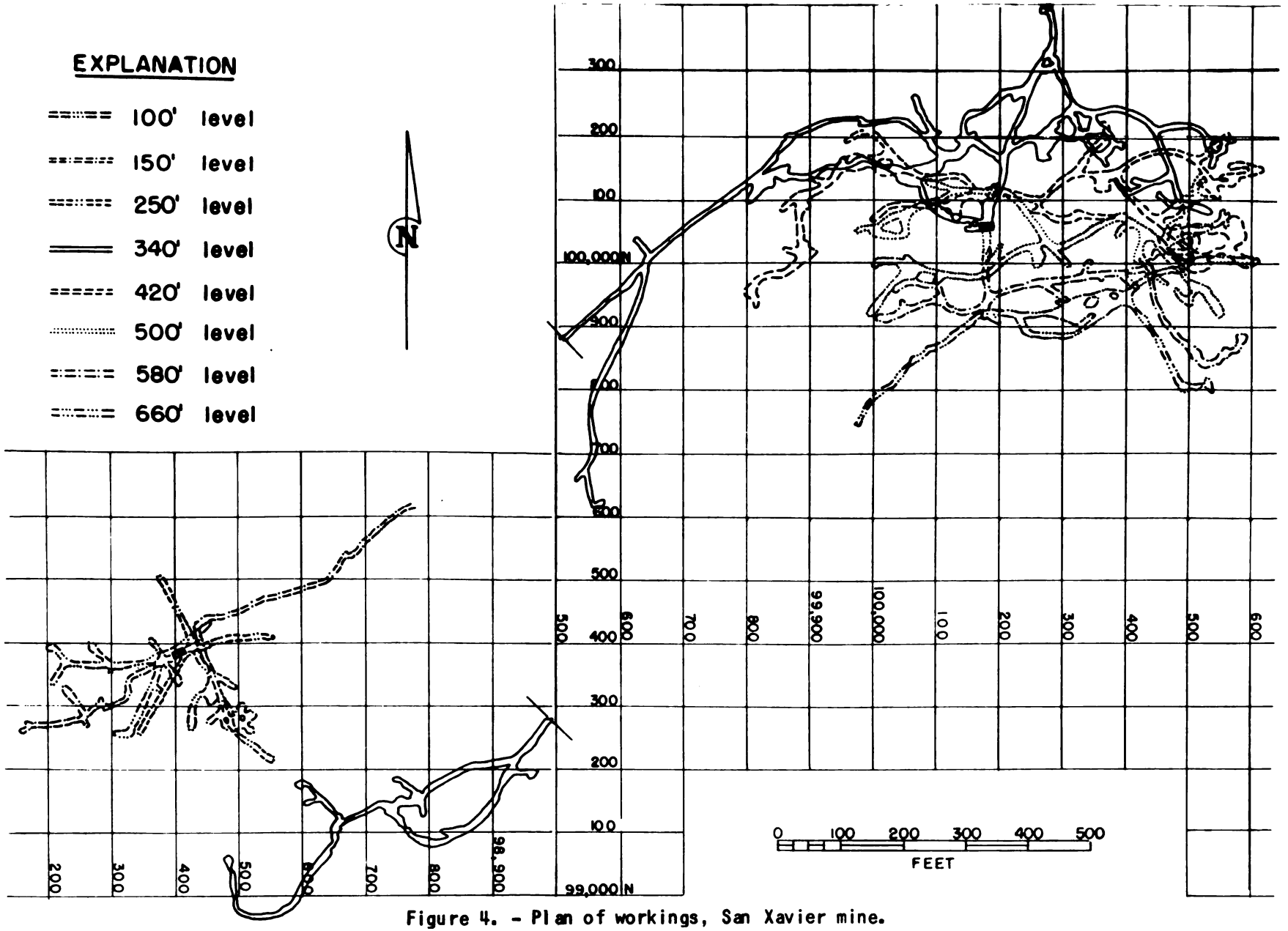

Figure 4. - Plan of workings, San Xavier mine.

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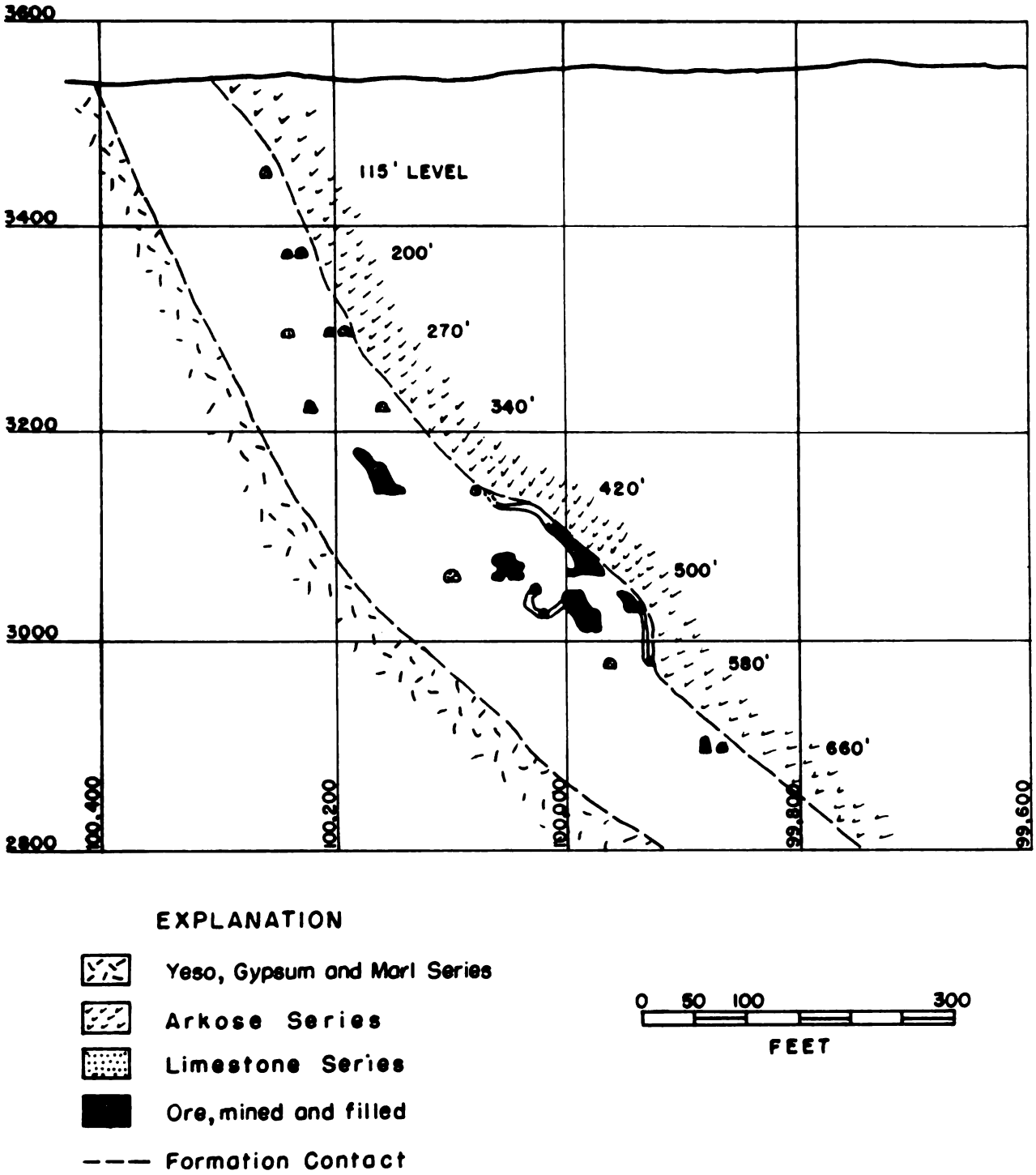

Figure 5. - Vertical section looking N. 68° E through point 100,000 N. - 100,044 E., San Xavier mine.

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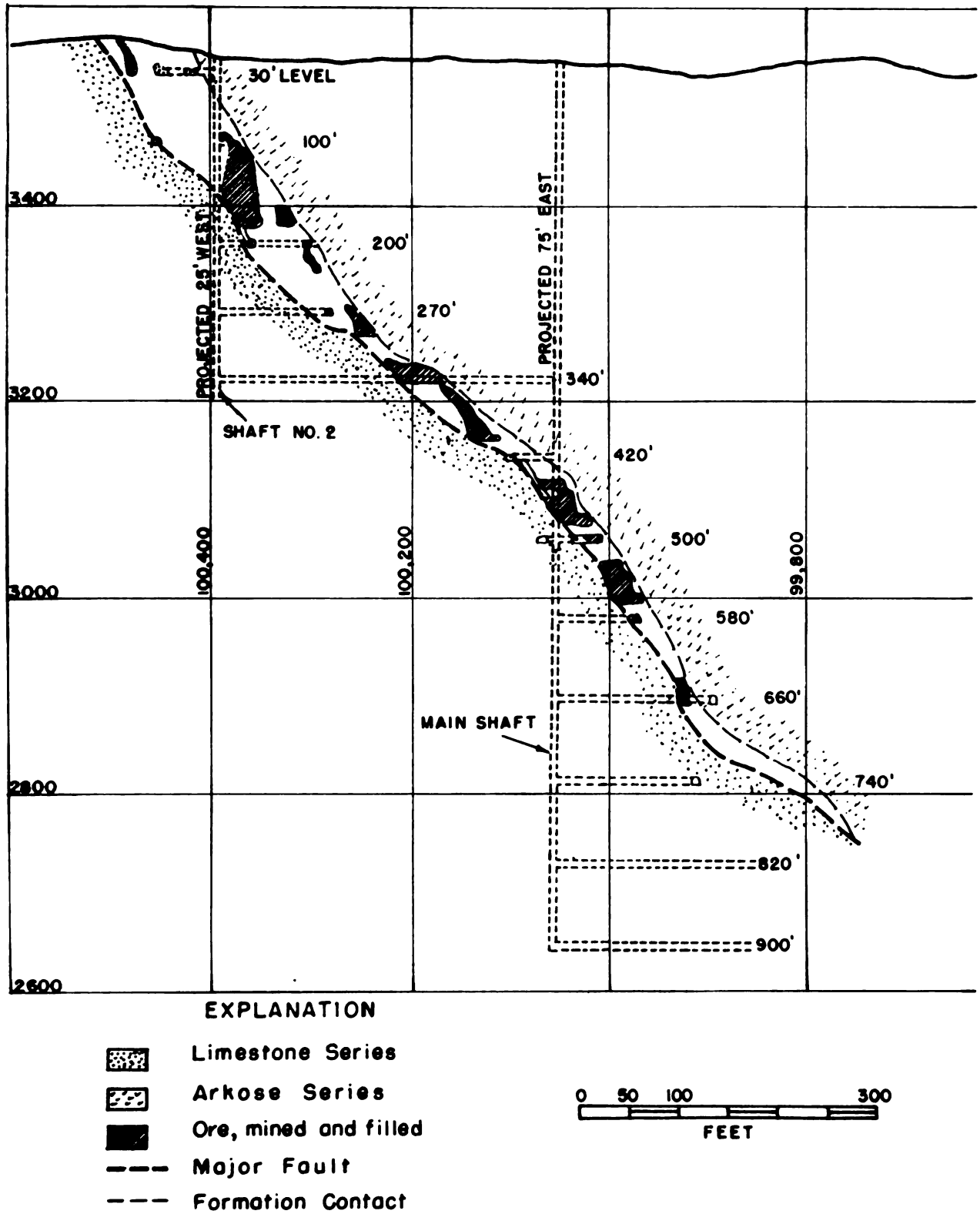

Figure 6. - Vertical section looking east along coordinate 100,250 E.

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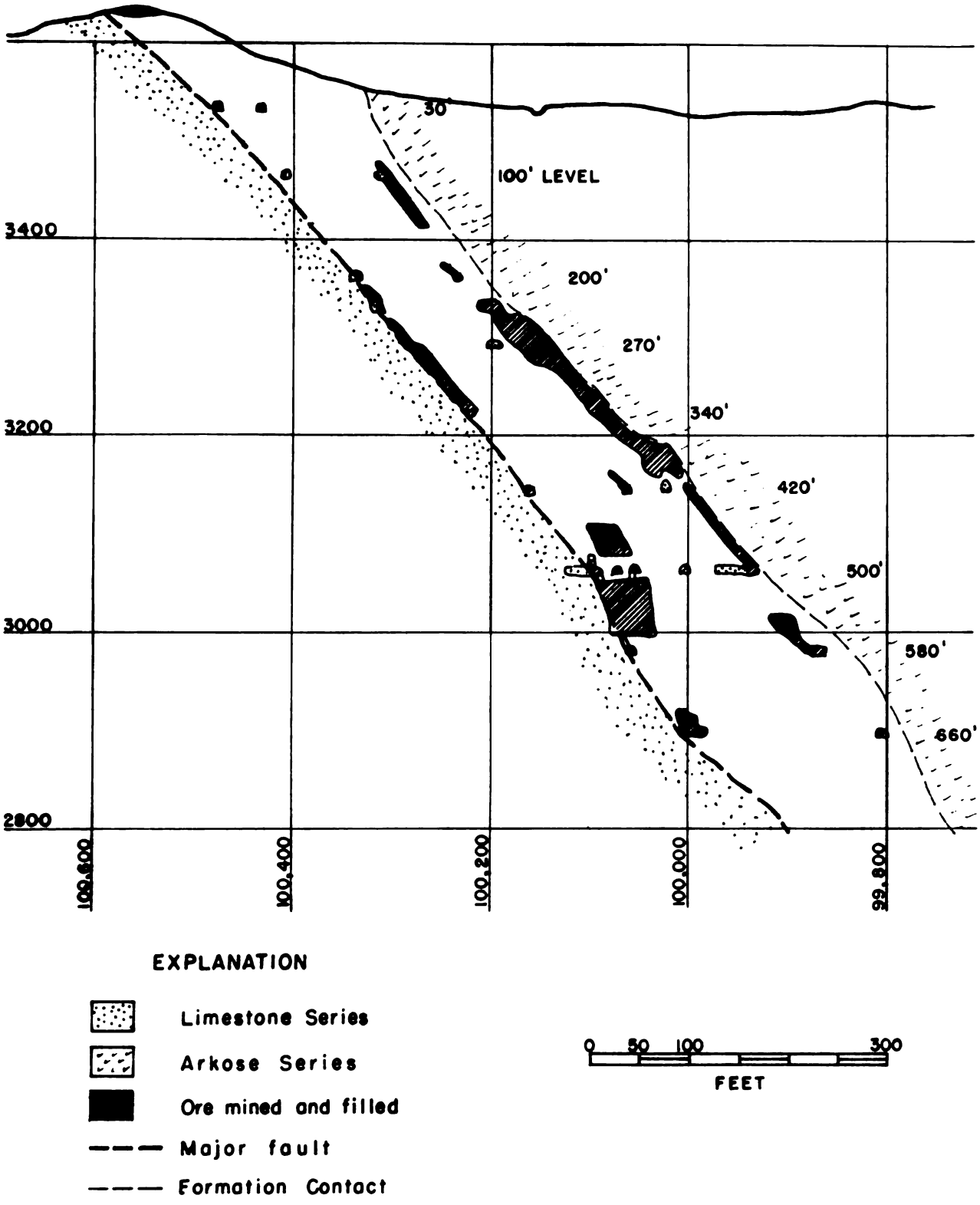

Figure 7. - Vertical section looking east along coordinate 100,500 E.

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Major Items in the Above Buildings

In the office building are the mine superintendent's office, engineer, geology, and drafting rooms.

The warehouse building contains the timekeeper's office and foreman's office as well as a tool room and lamp room.

The hoist house contains a double-drum, 5,000-pound capacity, 500-f.p.m., motor-driven, gear-connected hoist. The drums carry 1,300 feet of non-rotating 3/4-inch cable.

Compressor and power plant: This is a rather large building and houses six Diesel engines direct-connected to generators with a combined output of 1,440 horsepower; also two compressors with a total capacity of 1,500 c.f.m.

The engines now are maintained only as a stand-by power plant. Power is furnished by the Tucson Gas, Electric Light & Power Co. through a recently constructed 7-mile, 44,000-volt line extended from the Sahuarita mill to the mine. Interlocking switching arrangements can quickly convert to either power source. Substations step down to 2,300, 220, and 110 volts as required.

The machine shop is equipped with conventional lathes, shaper, bolt and pipe threaders, power saw, drill presses, arc and acetylene welding machines, and small tools.

Blacksmith shop: This shop is equipped with the usual forges, drill sharpeners, furnace, bit grinder, emery wheels, etc.

The saw mill building contains power rip-saw, cut-off saw, wedge saw, and saw gummer machine. All drift, raise, shaft, and square-set stope timbers are framed here by placing additional saws on the cut-off saw mandrill.

EXPLORATION AND DEVELOPMENT

Exploration at the San Xavier mine has followed the customary procedure in developing vein mines. Shafts are sunk, stations are cut at regular intervals, and, from the completed stations, crosscuts are driven to locate the vein or veins. Drifting on the vein is the next step, and where sufficient ore has been exposed, raises are run to help block out the ore and prepare it for stoping.

Development work is more complicated because the ore occurs in irregularly spaced ore shoots or lenses (figs. 4, 5, 6, 7).

Below the 340 level in the main working shaft, stations are spaced at 80-foot intervals instead of the customary 100 feet, on account of the

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irregular outlines of the ore bodies or lenses. The purpose of the main crosscut from a shaft station is to cut through the favorable limestone beds. The east and west drifting from this crosscut is done through the ore zones where the pipes or chimneys of ore are encountered. Familiarity with the nature and occurrence of these ore shoots is a help in directing the drifting operations. A careful study of the mine maps to determine the trend of each ore shoot is most essential.

After a reasonable amount of development has been completed on a new level, raises are driven through the ore to the level above. The locations of the raises are determined by the size and shape of each ore shoot. Wherever possible, the raises are located near the center and on the footwall side of the ore shoots.

A considerable amount of underground core drilling is done in connection with development work, and this results in obtaining valuable geological information on existing and proposed levels. On the bottom levels, some of these diamond-drill holes have been useful in gradually lowering the water table so that development drifts will not encounter a sudden inflow of water beyond the capacity of the pumps.

Development footages for 1948 and 1949 are classified as follows:

	1948	1949
Drifts and crosscuts	4,798	3,836
Raises	2,208	1,507
Shaft sinking	516	258
Diamond drilling	10,944	12,501

SHAFTS

Past production was handled through the following shafts:

No. 1: This is a 2-compartment inclined shaft (50°). It bottoms just below the 340 level. In 1882 this shaft had a depth of 245 feet. There is no longer a headframe over this shaft. It is now in use as the main ventilation shaft and is equipped with an exhaust fan of 24,000 c.f.m. capacity.

No. 2: This is a 1-1/2-compartment vertical shaft down to the 340-foot level. In 1882 this shaft had a depth of 148 feet. It was formerly used by the present owners as the main hoisting shaft and is still equipped with hoist and steel headframe.

No. 3: This shaft is a short distance east of No. 2 (water) shaft. It is an old 200-foot inclined shaft and has been abandoned for a number of years.

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No. 4: This is a 1-1/2-compartment vertical shaft to the west of the present main shaft. It is 150 feet deep. A small amount of work was done at the bottom, but these workings did not connect with the main mine. This shaft has been abandoned.

No. 5: This is an old 2-compartment 100-foot vertical shaft. It is still open as an emergency exit.

No. 6: This is one of the older shafts on the property. It is a 1-1/2-compartment 250-foot vertical shaft. Considerable work was done here in early days. This shaft, located 1,600 feet west of the present main hoisting shaft, is still open but not in use at the present time except as an escapeway and ventilation discharge. A raise was driven from the 340-foot level of the main mine workings, which connects with the old 250-foot level of the No. 6 shaft.

No. 7: All present production is hoisted through shaft 7. This is the main working shaft, which was completed and put into operation June 15, 1948. It has three compartments and is equipped with a modern 72-foot steel headframe. Embodied in the structure of the headframe are three steel bins with a total capacity of 450 tons. Little waste storage capacity is required on the surface, as virtually all development waste is used for stope filling. The steel bins are equipped with Stephens-Adamson undercut, air-operated chute gates for loading into trucks. Ore is hoisted in the mine cars and distributed to the three bins by means of semiautomatic turntables.

The present depth of the No. 7 shaft is 924 feet. Stations have been cut at the following levels: 340, 420, 500, 580, 660, 740, 820, and 900. From the 855-foot mark to the 900-foot level, a fourth compartment was added while sinking was in progress. This was done to allow for installation of shaft equipment on that level if desired at a later date.

In addition to conventional electric signal devices from cager to hoistman, "howlers" for calling the cager are located on each station. A new type U. S. I. sound-powered telephone system has been installed, with instruments on each station as well as at the top-man's deck and in the hoist room.

At present all mine water is relayed from pumps on the lower levels to the 340 pump station at the No. 2 shaft. The new pumping plant on the 900-foot level consists of 3 units, each capable of delivering 330 g.p.m. to the surface. Each unit is a 6-stage centrifugal pump operating at a speed of 3,600 r.p.m. These units, as well as the auxiliary pumps on this level, are set 4 feet above the station to preclude flooding of motors in case of relatively short periods of power failure. The 25-foot shaft sump is unwatered by means of a small electric centrifugal pump placed just above the level and coupled to an ejector in the sump.

When the mine was idle, water stood at 200 feet below the shaft collar. At present, over a million gallons of water are being pumped from the mine daily.

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DRIFTS AND CROSSCUTS

Untimbered drifts and crosscuts are driven 6 feet wide and 8 feet high. Where timber is required, 8- by 8-inch Oregon fir is used (fig. 8). Open mine workings require frequent barring-down and careful watching. To avoid the hazards from fall of rock, most of the mine openings are timbered.

Nearly all drifts and crosscuts are driven on a contract basis, and payment is at the rate of $8 per foot, the company furnishing all supplies. Timbering is installed on a contract basis, and payment is at the rate of $12.50 per set. Most of the mucking in the drifts is done with small mucking machines. In contract drifts, the contractor places the track, and a company pipeman keeps the air and water lines near the face. Standard 1-ton (16-cu. ft.) mine cars, turntable-mounted, end-dump, and roller-bearing, are used. Tramming is done either by hand or with 1-1/2-ton storage-battery locomotives.

The main shaft cages are large enough to permit locomotives and mucking machines to be moved quickly from one level to another.

RAISES

Raises through the ore bodies are 5 by 7 feet in cross section and have a manway separated from the chute compartment by 3-inch lagging nailed to 8- by 8-inch stulls. Timber and supplies for the raise work are hoisted by hand, as the raises seldom exceed 100 feet in length. Some of the raises are driven on contract at a cost of $10 per foot, the company furnishing all supplies.

If the horizontal area of the sill floor of a stope exceeds 1,000 square feet, a second raise usually is driven from the level to the stope floor. In this case the raise is carried up with the stope.

STOPING

No one stoping method can be designated as standard procedure at the San Xavier mine. Existing conditions in each ore shoot determine what method will be employed in mining that particular ore body.

A part of the past production has come from horizontal cut-and-fill stopes. After completing the raise through the ore shoot, a decision is made whether the ore will be mined by the open cut-and-fill or the square-set method. No stopes are being mined by the cheaper shrinkage method because the ore is too blocky, and the hanging wall is irregular and not strong enough to prevent dilution when the stope is drawn.

On the lower levels the ground has gradually become heavier and more blocky, so that at the present time all openings are being timbered on the levels and all the stopes are supported by square-set timbering (fig. 9).

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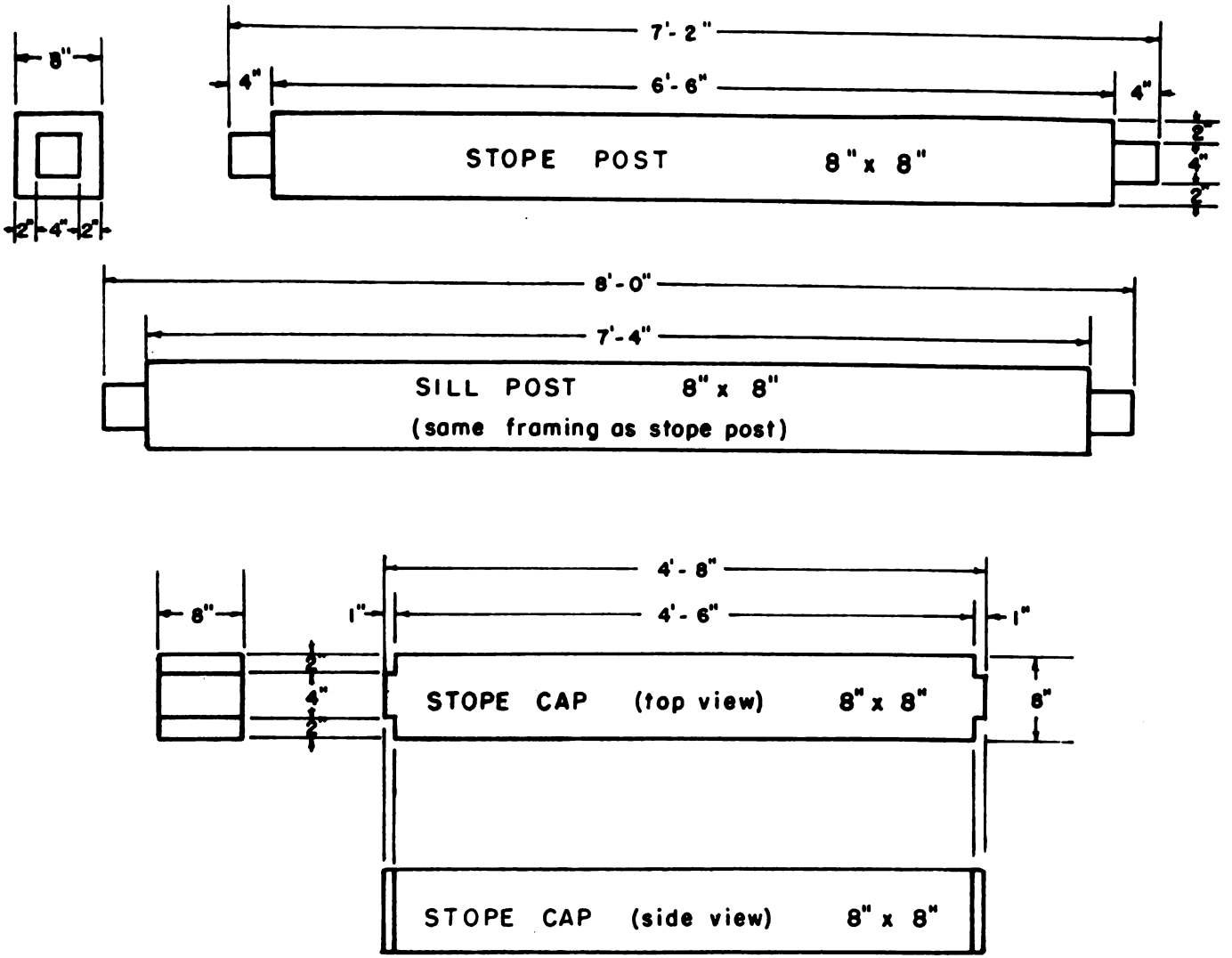

Sets are separated by an unframed girt - 6"x 8" x 56"

Figure 8. - Framing details for 8- by 8-inch stope, sill posts, and caps.

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Figure 9. - Timbering in San Xavier mine.

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If it has been decided to mine a stope by the horizontal cut-and-fill method, the stope is silled off 20 feet above the level. A 7-foot horizontal cut is taken through the entire ore body by drifter drills mounted on vertical bars. A floor of 3-inch lagging then is laid on 8- by 8-inch stringers spaced on 5-foot centers. This is standard practice in mining to prevent dilution when the sill pillar is mined at a later date. Waste fill now is added from the level above through the development raise and spread evenly over the floor with a small air-powered slusher to within 3 feet of the back. A floor of 2-inch lagging then is laid on the waste fill, and the stope is ready for the next horizontal cut of ore. When the ore from this next cut has been slushed into the ore chute, the 2-inch lagging is taken up and waste fill is again added. This cycle is repeated until the stope has been completed.

A stull or crib is used when the back develops a weak or blocky spot. If the back becomes too heavy, a change to square-set support is made. The square sets usually are filled as the stope progresses.

Square-set stopes differ from the cut-and-fill stopes just described, as they are silled off on the level instead of 20 feet above it. They are carried up the same as the cut-and-fill stopes.

If a stope shows considerable weight on the square-set timber before a floor is completed, the sets are tightly filled, leaving one row open for access to the working face. Access to the ore chute also is kept open.

In the No. 1 ore zone 200 feet west of the main shaft and on the footwall side of the mineralized limestone area, a little ore was mined by open-stope methods. The ore here occurred as lenses of considerable length but of little vertical height. The ore was silled out on the level and mucked into cars with a mucking machine. The back then was drilled with stopers and blasted onto the level floor. If a third round was necessary, it was drilled from the muck pile. Any ore that extended below the level more than a few feet was left to be mined from the level below.

All stopes are filled mainly with development waste. Where more fill is required, a power shovel on the surface loads dump trucks, and these trucks dump their loads into a waste pass extending to all levels with discharge chutes as required. In a few instances in the past when dry sand was available in a nearby arroyo, the sand has been similarly loaded and dumped into an 8-inch churn-drill hole. Mine cars were filled at the bottom of the churn-drill hole through a temporary chute, and the sand was trammed to the stope for fill. The sand must be dry to pass freely through the churn-drill hole.

METHODS OF SAMPLING

No regular cut samples are taken in stopes or development workings. A grab sample is taken from each car of ore at the shaft station where sample

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boxes are provided for all active working places on the level. These samples are collected and sent to the surface at the end of each shift to be assayed. No composites are made of the mine samples for checking against the daily mill head. To maintain production from a number of stopes, it usually is necessary to drill and blast in each stope on every shift. It therefore is necessary to obtain prompt returns on daily mine samples from each producing section and, of even greater importance, to rely on the ability of the mine bosses to distinguish ore from waste. The character and appearance of the ore enables the bosses, after reasonable experience, to make this distinction.

VENTILATION

The main hoisting shaft is downcast. The No. 1 shaft has a 24,000 cu. ft. suction fan over it. This fan is equipped with a 25-horsepower motor. Ventilation doors on all main levels control the flow of air through raises and stopes. Comfortable working temperatures are thus maintained throughout the mine.

A second fan, located in the west haulage drift on the 340 level, forces part of the fresh intake air up No. 6 shaft and through several old churn drill holes in that area.

UNDERGROUND EQUIPMENT

In addition to an ample supply of working tools, mining equipment consists of 5 small mucking machines, 15 self-rotating stoper drills, 12 drifters, 15 jackhammers, 2 storage-battery locomotives, 2 diamond drills, 7 slusher hoists, and 3 underground air receivers (fig. 10).

All mine rock drills have lugged chucks for 1-inch round, hollow drill steel. Detachable steel bits are used for all drilling. Dull bits are resharpened, and drill rods are made up and reconditioned in the mine blacksmith shop. Bit-carrying racks are checked in and out to miners each shift, as well as axes, saws, levels, and other equipment.

WATER SUPPLY

At the present time a million gallons of water is being pumped from the mine daily. The water is clear and pure and is being used for domestic purposes in the mine dwellings. The domestic water is chlorinated as a precautionary measure, and regular analyses are made by the Tucson office of the State Health Department.

The plant at Sahuarita obtains an ample supply of domestic and mill water from two deep wells near the plant.

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Mucking machine

Diamond drill

Rock drill

Figure 10 . - Mucking and drilling operations.

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MILLING PRACTICE

The Sahuarita mill is approximately 2 miles west of Sahuarita, Ariz., on the west slope of the Santa Cruz River Valley. The plant is connected by a railroad spur to the main line of the Southern Pacific Railroad between Tucson and Nogales, which enables shipping custom ores directly to the plant via rail.

Power for the mill is obtained from the Tucson Gas, Electric Light & Power Co. and is transmitted at 44,000 volts, transformed to 2,300 and 220 volts at a substation on the property. Water is obtained from two deep wells, in which the water stands at about 90 feet below the surface. Pumping is done with deep-well pumps.

Ore is hauled from the San Xavier mine to the mill, a distance of 10 miles, in trucks with trailers and also in Diesel trucks equipped with end-dump bodies and hydraulic lifts. Custom ore from outside shippers is either hauled to the mill by truck or delivered in railroad cars. Adequate coarse-ore bin capacity is provided for each class of ore being received.

Milling is conventional lead-zinc selective flotation, producing a lead concentrate containing the silver and copper and a zinc concentrate. Capacity of the plant is 500 tons of crude ore per 24 hours. The crushing plant normally operates one shift per day, whereas the concentrator runs 24 hours per day.

Primary crushing is done in a 24-inch Blake-type jaw crusher, and secondary crushing in a 3-foot cone. The discharge from the latter is sampled by a series of Vezin automatic samplers, which give a final sample of 1 pound per ton of ore. Sample rejects, comprising the mill feed, pass to secondary storage consisting of four 200-ton bins and one 150-ton bin.

Primary grinding equipment is composed of one 8-foot by 36-inch conical ball mill and one 6- by 4-foot ball mill. Both mills operate in closed circuit with one 60-inch spiral classifier. Ore is ground to approximately 70 percent through 100 mesh for liberation of the sulfide minerals.

Flotation takes place in four 66-inch machines for lead roughing and six machines of the same make and size for zinc roughing with 10 minutes' conditioning before zinc flotation. Zinc is cleaned in two 66-inch cells, and lead is cleaned in eight other cells. The only unique feature of the circuit is that the scavenger concentrate from the last three cells of the zinc rougher circuit is reground with cyanide in a 4- by 4-foot ball mill and then returned to the head of the lead circuit.

Both lead and zinc concentrates are thickened, filtered in two 6-foot, 4-leaf filters, and conveyed to storage bins. Loading into railroad box cars is done with moveable belt-conveyor rig discharging into a car loader. Lead concentrates are shipped to El Paso for smelting, and zinc concentrates to Henryetta, Okla.

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Mill tailings are pumped through a 4-inch pipe line 1,100 feet to a series of tailings and settling ponds.

Housing facilities are furnished virtually all mill employees at the millsite.

Buildings and structures include main building, primary crusher building, secondary crusher building, automatic sampling plant, 5 conveyor-belt housings, 4 concrete coarse-ore bins, 5 wooden fine-ore bins, 3 wooden concentrate bins, 2 scale houses, 3 pumphouses, 21 dwellings, a machine shop, change house, warehouse, research laboratory, assay office, sample bucking house, main offices, a water tank, and a substation.

TRANSPORTATION

Virtually all mine employees live in Tucson. Large, comfortable buses, operated under State franchise by the Citizens Auto Stage Co., furnish good transportation for all shifts from Tucson.

LABOR AND WAGE SCALES

San Xavier Mine Pay Rates as of March 1, 1949

Mine Department

Classification	Day rate
Shaft lead man	$11.68
Shaft man	11.44
Timberman	10.96
Timberman's helper	9.80
Miner	10.56
Mucker	9.80
Trammer	9.80
Bucket dumper	9.80
Scraper man	10.56
Mucking-machine operator	10.56
Nipper	10.56
Motorman	10.56
Pumpman	10.56
Pipe man	10.56
Pipe man's helper	9.80
Track man	10.56
Track man's helper	9.80
Cager	10.80
Topman	10.56

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Mechanical Department

Hoistman, double-drum	$11.32
Hoistman, single-drum	10.64
Carpenters	10.72
Carpenter's helper	9.72
Timber framer	10.40
Blacksmith	10.80
Blacksmith's helper	9.72
Power shovel operator	10.80
Electrician	10.80
Electrician's helper	9.72
Mechanic, first class	11.12
Mechanic, regular	10.40
Mechanic's helper	9.72
Welder	10.80
Shopman	10.40
Shopman's helper	9.72
Diesel operator	10.80
Handy man	10.40
Truck driver	10.40
Laborer	9.44

Sahuarita Mill Pay Rates as of March 1, 1949

Classification	Day rate
Ball mill operator	$9.64
Filterman	9.44
Concentrate loader	9.96
Concentrate loader's helper	9.44
Crusherman	9.96
Sampleman	9.96
Welder	10.80
Handyman	10.40
Truck driver	10.40
Scaleman	9.80
Laborer	9.44

A shift differential of 4 cents per hour for afternoon shift and 8 cents per hour on graveyard shift is granted.

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